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Mitchell G. Spiegel
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Mike Placko
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H. Clergeot, D. Placko, J. M. Detriche
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generated by DPSM are compared with those obtained analytically. Good qualitative matching between the two sets of mode shapes is obtained. This analysis shows that when bounded acoustic beams strike a corrugated plate at an angle, the elastic waves can propagate in both forward and backward directions in the waveguide depending on the degree of corrugation. The back propagation of ultrasonic waves in corrugated waveguides for large corrugation depth is reported for the first time in this paper.

ACKNOWLEDGMENTS

The authors thank Dr. A. Boström and Dr. A. El-Bahrawy, Chalmers University of Technology, Division of Mechanics, Göteborg, Sweden and Dr. A. K. Mal, University of California, Los Angeles, for sending valuable research material on this subject. This research was partially funded by a grant from the National Science Foundation under Contract No. CMS-9901221.

APPENDIX:

Matrices expressions:

$$\mathbf{DSn}_{TS}=\begin{bmatrix} \mathbf{Gn}_1^1 & \mathbf{Gn}_1^2 & \mathbf{Gn}_1^3 & \cdots & \mathbf{Gn}_1^{M-1} & \mathbf{Gn}_1^M \\ \mathbf{Gn}_2^1 & \mathbf{Gn}_2^2 & \mathbf{Gn}_2^3 & \cdots & \mathbf{Gn}_2^{M-1} & \mathbf{Gn}_2^M \\ \mathbf{Gn}_3^1 & \mathbf{Gn}_3^2 & \mathbf{Gn}_3^3 & \cdots & \mathbf{Gn}_3^{M-1} & \mathbf{Gn}_3^M \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \mathbf{Gn}_{N-1}^1 & \mathbf{Gn}_{N-1}^2 & \mathbf{Gn}_{N-1}^3 & \cdots & \mathbf{Gn}_{N-1}^{M-1} & \mathbf{Gn}_{N-1}^M \\ \mathbf{Gn}_N^1 & \mathbf{Gn}_N^2 & \mathbf{Gn}_N^3 & \cdots & \mathbf{Gn}_N^{M-1} & \mathbf{Gn}_N^M \end{bmatrix}_{(Nx3M)}, \tag{A1}$$

$$\mathbf{S22}'_{TS}=\begin{bmatrix} \mathbf{s}_{22^1}^1 & \mathbf{s}_{22^1}^2 & \mathbf{s}_{22^1}^3 & \mathbf{s}_{22^1}^4 & \mathbf{s}_{22^1}^5 & \cdots & \cdots & \mathbf{s}_{22^1}^{M-2} & \mathbf{s}_{22^1}^{M-1} & \mathbf{s}_{22^1}^M \\ \mathbf{s}_{22^2}^1 & \mathbf{s}_{22^2}^2 & \mathbf{s}_{22^2}^3 & \mathbf{s}_{22^2}^4 & \mathbf{s}_{22^2}^5 & \cdots & \cdots & \mathbf{s}_{22^2}^{M-2} & \mathbf{s}_{22^2}^{M-1} & \mathbf{s}_{22^2}^M \\ \mathbf{s}_{22^3}^1 & \mathbf{s}_{22^3}^2 & \mathbf{s}_{22^3}^3 & \mathbf{s}_{22^3}^4 & \mathbf{s}_{22^3}^5 & \cdots & \cdots & \mathbf{s}_{22^3}^{M-2} & \mathbf{s}_{22^3}^{M-1} & \mathbf{s}_{22^3}^M \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \mathbf{s}_{22^{N-2}}^1 & \mathbf{s}_{22^{N-2}}^2 & \mathbf{s}_{22^{N-2}}^3 & \mathbf{s}_{22^{N-2}}^4 & \mathbf{s}_{22^{N-2}}^5 & \cdots & \cdots & \mathbf{s}_{22^{N-2}}^{M-2} & \mathbf{s}_{22^{N-2}}^{M-1} & \mathbf{s}_{22^{N-2}}^M \\ \mathbf{s}_{22^{N-1}}^1 & \mathbf{s}_{22^{N-1}}^2 & \mathbf{s}_{22^{N-1}}^3 & \mathbf{s}_{22^{N-1}}^4 & \mathbf{s}_{22^{N-1}}^5 & \cdots & \cdots & \mathbf{s}_{22^{N-1}}^{M-2} & \mathbf{s}_{22^{N-1}}^{M-1} & \mathbf{s}_{22^{N-1}}^M \\ \mathbf{s}_{22^N}^1 & \mathbf{s}_{22^N}^2 & \mathbf{s}_{22^N}^3 & \mathbf{s}_{22^N}^4 & \mathbf{s}_{22^N}^5 & \cdots & \cdots & \mathbf{s}_{22^N}^{M-2} & \mathbf{s}_{22^N}^{M-1} & \mathbf{s}_{22^N}^M \end{bmatrix}_{(Nx3M)}, \tag{A2}$$

$$\mathbf{DFn}_{TS}=\begin{bmatrix} g(R_{i1}^1,r_1^1) & g(R_{i1}^2,r_1^2) & g(R_{i1}^3,r_1^3) & \cdots & g(R_{i1}^{M-1},r_1^{M-1}) & g(R_{i1}^M,r_1^M) \\ g(R_{i2}^1,r_2^1) & g(R_{i2}^2,r_2^2) & g(R_{i2}^3,r_2^3) & \cdots & g(R_{i2}^{M-1},r_2^{M-1}) & g(R_{i2}^M,r_2^M) \\ g(R_{i3}^1,r_3^1) & g(R_{i3}^2,r_3^2) & g(R_{i3}^3,r_3^3) & \cdots & g(R_{i3}^{M-1},r_3^{M-1}) & g(R_{i3}^M,r_3^M) \\ g(R_{i4}^1,r_4^1) & g(R_{i4}^2,r_4^2) & g(R_{i4}^3,r_4^3) & \cdots & g(R_{i4}^{M-1},r_4^{M-1}) & g(R_{i4}^M,r_4^M) \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ g(R_{iN}^1,r_N^1) & g(R_{iN}^2,r_N^2) & g(R_{iN}^3,r_N^3) & \cdots & g(R_{iN}^{M-1},r_N^{M-1}) & g(R_{iN}^M,r_N^M) \end{bmatrix}_{(NxM)}, \tag{A3}$$

where

$$g(R_{in}^m,r_n^m)=\frac{1}{\rho\omega^2}\left[\left(\frac{1}{r_n^m}ik_fR_{2n}^m e^{ik_fr_n^m}-\frac{e^{ik_fr_n^m}}{(r_n^m)^2}R_{2n}^m\right)n_2 + \left(\frac{1}{r_n^m}ik_fR_{1n}^m e^{ik_fr_n^m}-\frac{e^{ik_fr_n^m}}{(r_n^m)^2}R_{1n}^m\right)n_1\right],$$

$R_{in}^m=(x_{in}^m-y_{in}^m)/r_n^m$ and i take values 1, 2, and 3, except an imaginary quantity.

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